Translation

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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference P30670 -P0	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/JP2003/003546	International filing date (*day/month/year*) 24 March 2003 (24.03.2003)	Priority date (*day/month/year*) 27 March 2002 (27.03.2002)
International Patent Classification (IPC) or national classification and IPC G01R 33/02		
Applicant MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 3 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 5 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
16 September 2003 (16.09.2003)	23 February 2004 (23.02.2004)
Name and mailing address of the IPEA/JP Facsimile No.	Authorized officer Telephone No.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/JP2003/003546

I. Basis of the report

1. With regard to the **elements** of the international application:*

☐ the international application as originally filed

☒ the description:

pages 1-50, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

☒ the claims:

pages 5-32, 34, 36-41, as originally filed
pages _____, as amended (together with any statement under Article 19
pages _____, filed with the demand
pages 1-4, 33, 35, filed with the letter of _____

☒ the drawings:

pages 1-33, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

☐ the sequence listing part of the description:

pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____

☐ the claims, Nos. _____

☐ the drawings, sheets/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rule 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/JP03/03546

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-41	YES
	Claims		NO
Inventive step (IS)	Claims	1-41	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-41	YES
	Claims		NO

2. Citations and explanations

Document 1: US, 5838154, A (Toyota Central R&D Labs., Inc.), 17 November, 1998 (17.11.98)
Document 2: JP, 10-90382, A (NEC Tokin Corp.), 10 April, 1998 (10.04.98)
Document 3: JP, 9-113590, A (Canon Electronics Inc.), 2 May, 1997 (02.05.97)

The magnetic sensing elements described in document 1 (Fig. 1) and document 2 (Figs. 4 and 5) have a constitution wherein the area of a cross section of the magnetic core of a soft magnetic film perpendicular to the magnetic path near the periphery of the conductor wire is smaller than those of other parts, and so it can be seen that the magnetic core is thinner there.

Document 3 (Fig. 5) discloses a magnetic sensing element whose second magnetic core is made thinner.

None of the above-mentioned documents, however, describes a feature wherein an alternating current superimposed by a direct bias current flows through a conductive wire.

A new effect of cooperation of the said feature and the magnetic core with a thin part is that the rate of change in the permeability in terms of external magnetic fields is increased, which in turn increases the sensitivity.

Accordingly, the subject matters of claims 1-41 appear to be novel and to involve an inventive step.

It is also clear that the subject matters of claims 1-41 are industrially applicable in the area of magnetic sensors.

CLAIMS

1. (Amended) A magnetic detection device comprising:

a first magnetic core of a soft magnetic film,

a conductive wire formed on said first magnetic core at a portion thereof, and

a second magnetic core of a soft magnetic film formed on said first magnetic core so as to hold said conductive wire therebetween, the area of the cross-section perpendicular to a magnetic path being partially different, therein

a current in which a DC bias current is superimposed on an AC current is let to flow through said conductive wire.

2. (Amended) A magnetic detection device comprising:

a first magnetic core of a soft magnetic film, the area of the cross-section perpendicular to a magnetic path being partially different,

a conductive wire formed on said first magnetic core at a portion thereof, and

a second magnetic core of a soft magnetic film formed on said first magnetic core so as to hold

said conductive wire therebetween, the area of the cross-section perpendicular to a magnetic path being made smaller in the vicinities of the fringe portions of said conductive wire than that of the other portion, therein

a current in which a DC bias current is superimposed on an AC current is let to flow through said conductive wire.

3. (Amended) A magnetic detection device comprising:

a first magnetic core of a soft magnetic film,

a conductive wire formed on said first magnetic core at a portion thereof, and

a second magnetic core of a soft magnetic film formed on said first magnetic core so as to hold said conductive wire therebetween, the thickness of said second magnetic core being smaller than that of said first magnetic core, therein

a current in which a DC bias current is superimposed on an AC current is let to flow through said conductive wire.

4. (Amended) A magnetic detection device comprising:

a first magnetic core of a soft magnetic film,

a conductive wire formed on said first magnetic core at a portion thereof, and

a second magnetic core of a soft magnetic film formed on said first magnetic core so as to hold said conductive wire therebetween, the thickness of said second magnetic core being larger than that of said first soft magnetic core, therein

a current in which a DC bias current is superimposed on an AC current is let to flow through said conductive wire.

5. A magnetic detection device in accordance with claim 1 or 2, wherein the width of at least one of said first and second magnetic cores is made smaller in the vicinity of said conductive wire.

6. A magnetic detection device in accordance with claim 1 or 2, wherein said second magnetic core has a depressed portion or a hole in a region including said conductive wire to decrease the area of the cross-section perpendicular to a magnetic path of said second magnetic core.

7. A magnetic detection device in accordance

with claim 1 or 2, wherein said conductive wire is held between said first and second magnetic cores via insulation films.

8. A magnetic detection device in accordance with claim 1 or 2, wherein the ratio of the small portion and the large portion of the partially different cross-sectional areas of said first magnetic core and said second magnetic core is 3 to 4 or less.

9. A magnetic detection device in accordance with claim 1 or 2, wherein the thickness of at least one of said first and second magnetic cores is made smaller in the vicinity of said conductive wire.

10. A magnetic detection device in accordance with claim 1 or 2, wherein the thickness of said conductive wire in the vicinities of the fringe portions thereof is made smaller.

11. A magnetic detection device in accordance with any one of claims 1, 2, 3 or 4, wherein the thickness of at least one of said first and second magnetic cores in a region thereof including said conductive wire is partially made smaller.

12. A magnetic detection device in accordance with claim 1 or 2, wherein grooves are formed so that the area of the cross-section perpendicular to a magnetic path of said second magnetic core at the circumference of said conductive wire is made smaller than that at the other portion.

13. A magnetic detection device in accordance with any one of claims 1 to 4, wherein said first magnetic core and said second magnetic core are insulated by an insulation layer in a region including said conductive wire.

14. A magnetic detection device in accordance with claim 1 or 2, wherein the end regions of said first magnetic core have a two-layer structure.

15. A magnetic detection device in accordance with any one of claims 1 to 4, wherein the thickness of said conductive wire is larger than the thickness of one of said first magnetic core and said second magnetic core.

16. A magnetic detection device in accordance with claim 15, wherein the thickness of

said conductive wire is larger than the thickness of said second magnetic core.

17. A magnetic detection device in accordance with claim 15 or 16, wherein the ratio (thickness/length) of the thickness of said conductive wire to the length thereof in a direction parallel with the direction of a magnetic field to be detected is 1/4 or more.

18. A magnetic detection device comprising:

a first conductive wire formed in a predetermined region on one face of a first magnetic core of a soft magnetic film,

a second conductive wire formed in a region opposed to said first conductive wire on the other face of said first magnetic core,

a second magnetic core formed on said one face of said first magnetic core and on said first conductive wire, and

a third magnetic core formed on said other face of said first magnetic core and on said second conductive wire.

19. A magnetic detection device in accordance with claim 18, wherein the areas of the

respective cross-sections perpendicular to magnetic paths of said second and third magnetic cores are partially different.

20. A magnetic detection device in accordance with claim 18, wherein said first and second conductive wires contact said respective first, second and third magnetic cores via respective insulation films.

21. A magnetic detection device in accordance with claim 19, wherein the ratio of the thickness of a thin portion having a small cross-sectional area and the thickness of a thick portion having a large cross-sectional area in said second and third magnetic cores is 3 to 4 or less.

22. A magnetic detection device in accordance with claim 18, wherein the vicinities of portions opposed to the circumferences of said first and second conductive wires of said second and third magnetic cores are made thinner than the other portions.

23. A magnetic detection device in accordance with claim 18, wherein portions opposed to

said first and second conductive wires of said second and third magnetic cores are made thinner than the other portions.

24. A magnetic detection device in accordance with claim 18, wherein said second and third magnetic cores have grooves at portions opposed to said first and second conductive wires.

25. A magnetic detection device in accordance with claim 18, wherein the regions, at the circumferences of said first and second conductive wires, of said second and third magnetic cores are removed.

26. A magnetic detection device in accordance with claim 18, wherein said first magnetic core is made thinner than said second and third magnetic cores.

27. A magnetic detection device in accordance with claim 18, wherein the thicknesses of said first and second conductive wires are larger than the thicknesses of said second and third magnetic cores.

28. A magnetic detector comprising:

a first magnetic core of a soft magnetic film, the cross-sectional area of which is partially different,

a conductive wire formed on said first magnetic core at a portion thereof,

a second magnetic core of a soft magnetic film formed on said first magnetic core and said conductive wire so as to hold said conductive wire therebetween, the area of the cross-section perpendicular to a magnetic path of said second magnetic core being partially different,

magnetic bias means for applying a bias magnetic field in the direction parallel to the direction of a magnetic field to be detected to said first and second magnetic cores, and

an AC carrier signal generator for flowing an AC current to said conductive wire in a direction perpendicular to said magnetic field to be detected.

29. A magnetic detector comprising:

a first conductive wire formed in a predetermined region on one face of a first magnetic core of a soft magnetic film,

a second conductive wire formed in a region opposed to said first conductive wire on the other

face of said first magnetic core,

a second magnetic core of a soft magnetic film formed on said one face of said first magnetic core and on said first conductive wire, the area of the cross-section perpendicular to a magnetic path of said second magnetic core being partially different,

a third magnetic core made of a soft magnetic film and formed on said other face of said first magnetic core and on said second conductive wire, the area of the cross-section, perpendicular to a magnetic path, of which is partially different,

magnetic bias means for applying a bias magnetic field in the direction parallel to the direction of a magnetic field to be detected to said first, second and third magnetic cores, and

an AC carrier signal generator for flowing AC carrier currents to said first and second conductive wires in a direction perpendicular to said detected magnetic field.

30. A magnetic detector in accordance with claim 29, wherein AC carrier currents having the same phase are let to flow through said first and second conductive wires, and DC currents having directions opposite to each other are let to flow through said first conductive wire and said second conductive wire,

thereby applying a DC bias magnetic field.

31. A magnetic detector in accordance with claim 29, wherein one end of said first conductive wire is connected to one end of said second conductive wire so as to form a coil enclosing said first magnetic core.

32. A magnetic detector in accordance with claim 29, wherein AC carrier currents having phases opposite to each other are let to flow through said first conductive wire and said second conductive wire, and DC currents having directions opposite to each other are let to flow through said first conductive wire and said second conductive wire, thereby applying a DC bias magnetic field.

33. (Amended) A magnetic detection device comprising:

a first magnetic core of a soft magnetic film having a nearly rectangular shape and formed on a nonmagnetic substrate,

a plurality of first conductive wires formed on said first magnetic core at predetermined intervals in a direction perpendicular to the longitudinal direction of said rectangular first magnetic core,

a second magnetic core of a soft magnetic film formed on said first magnetic core so as to hold said first conductive wires therebetween, the area of the cross-section perpendicular to a magnetic path being partially different, and

a plurality of second conductive wires for connecting said plurality of first conductive wires in series, therein

a current in which a DC bias current is superimposed on an AC current is let to flow through said conductive wires.

34. A magnetic detection device in accordance with claim 33, comprising a plurality of magnetic detection devices, each comprising:

a first magnetic core of a soft magnetic film having a nearly rectangular shape and formed on a nonmagnetic substrate,

a plurality of first conductive wires formed on said first magnetic core at predetermined intervals in a direction perpendicular to the longitudinal direction of said rectangular first magnetic core,

a second magnetic core formed on said first magnetic core so as to hold said first conductive wires therebetween, the area of the cross-section perpendicular to a magnetic path of said second

magnetic core being partially different, and

a plurality of second conductive wires for connecting said plurality of first conductive wires in series, therein

said plurality of magnetic detection devices are arranged in parallel with said longitudinal direction, and said first and second conductive wires of the respective detection devices are all connected in series.

35. (Amended) A magnetic detection device comprising:

a plurality of first magnetic cores having a nearly rectangular shape and formed in parallel on a nonmagnetic substrate,

a plurality of first conductive wires formed on said plurality of first magnetic cores at predetermined intervals in a direction perpendicular to the longitudinal direction of said plurality of first magnetic cores,

second magnetic cores formed on said plurality of first magnetic cores so as to hold said first conductive wires therebetween, the areas of the cross-sections perpendicular to magnetic paths being partially different, and

second conductive wires for connecting all

of said plurality of first conductive wires in series, therein

a current in which a DC bias current is superimposed on an AC current is let to flow through said conductive wires.

36. A magnetic detection device in accordance with claim 35, wherein the thicknesses of said second magnetic cores in the vicinities of said first conductive wires are made smaller.

37. A magnetic detection device in accordance with claim 35, wherein among said plurality of first and second magnetic cores having a nearly rectangular shape and formed in parallel on said nonmagnetic substrate, those disposed at both end portions are made shorter than those disposed at the central portion.

38. A magnetic detection device in accordance with any one of claims 33 to 35, wherein said second conductive wires are conductive films formed on said second magnetic core.

39. A magnetic detection device in accordance with any one of claims 33 to 35, wherein

insulation films are provided between said first magnetic core and said first conductive wire, between said first conductive wire and said second magnetic core and between said second magnetic core and said second conductive wire.

40. A method of producing a magnetic detection device, comprising:

a step of forming a first magnetic core by forming a soft magnetic film in a desired pattern on a nonmagnetic substrate,

a step of forming a conductive wire by forming a conductive film in a desired pattern in a predetermined region of said first magnetic core,

a step of forming a second magnetic core by forming a soft magnetic film in a desired pattern on said first magnetic core and said conductive wire, and

a step of making the thickness of said second magnetic core smaller at predetermined portions thereof.

41. A method of producing a magnetic detection device, comprising:

a step of forming a first magnetic core by forming a soft magnetic film in a desired pattern on a nonmagnetic substrate,

a step of forming a first insulation film by forming a nonmagnetic and insulating film in a desired pattern on said first magnetic core,

a step of forming a conductive wire by forming a conductive film in a desired pattern on said first insulation film,

a step of forming a second insulation film made of a nonmagnetic and insulating film on said conductive wire,

a step of forming a second magnetic core, the cross-sectional area of which is partially different, by forming a soft magnetic film in a desired pattern on said first insulation film and said second insulation film, and

a step of making the end portions of said first magnetic core thicker by forming soft magnetic films in the end regions of said first magnetic core.